higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T580**(E)**(N18)T

NOVEMBER EXAMINATION

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N4

(15070434)

18 November 2014 (Y-Paper)
13:00–16:00

This question paper consists of 6 pages and 1 formula sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ENGINEERING SCIENCE N4
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Subsections of questions must be kept together.
5. Rule off across the page on completion of each section.
6. ALL formulae should be shown in the answers.
7. Show ALL the calculations.
8. Use only BLUE or BLACK ink.
9. ALL diagrams should be drawn in pencil.
10. ALL the answers must be rounded off to THREE decimal places.
11. Take g = 9,8 m/s^2.
12. Write neatly and legibly.

QUESTION 1

1.1 Ship A sails at 30 km/h north 48° west, whilst ship B is sailing at 20 km/h south 15° east, from the same point of reference.

Calculate the velocity of ship A relative to ship B in magnitude and direction. (5)

1.2 A bullet is fired at a velocity of 700 m/s and from an angle of 36° to the horisontal.

Calculate:

1.2.1 The maximum height which the bullet will reach (3)

1.2.2 The striking distance of the bullet (4)

1.3 A stone is projected vertically upwards to a height of 88 m.

Calculate the velocity with which the stone left the projecting device. (3)
[15]

QUESTION 2

2.1 Define *angular velocity*. (2)

2.2 A flywheel accelerates from 1 200 r/min to 1 800 r/min in 2 seconds.

Calculate:

2.2.1 The angular acceleration of the flywheel (3)

2.2.2 The number of revolutions made by the flywheel in 2 seconds (4)
[9]

QUESTION 3

3.1 Define *Newton's second law.* (2)

3.2 A vehicle with a mass of 1 200 kg accelerates uniformly, from rest up a gradient of 1 in 25 and reaches a speed of 54 km/h after 2 minutes.

Calculate:

3.2.1 The acceleration of the vehicle (2)

3.2.2 The kinetic energy that the vehicle possesses at the end of the 2 minutes (2)

3.2.3 The gain in potential energy of the vehicle (6)
[12]

QUESTION 4

4.1 A beam ABCDE is 4 m long and simply supported at the two ends as shown in FIGURE 1 below.

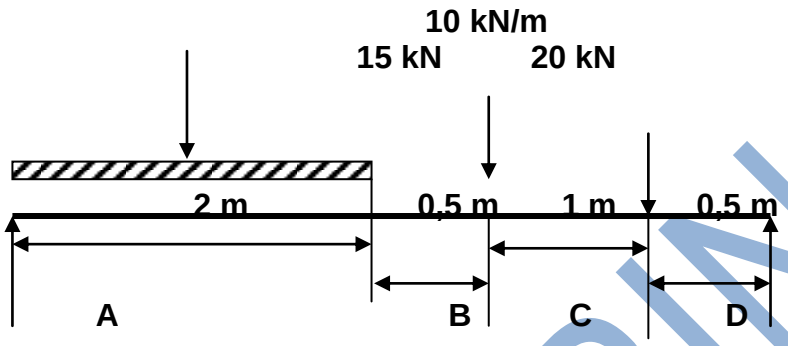

FIGURE 1

4.1.1 Calculate the reactions of the supports at points A and E. (4)

4.1.2 Draw the shear force and bending moment diagrams of the above beam and show ALL the main values on the TWO diagrams. (6)

4.2 The size of a rectangular plate is 100 mm x 50 mm. The upper right-hand corner is removed with a radius of 20 mm.

Calculate the centroid of the plate as shown in FIGURE 2 below from the Y–Y axis. (5)
[15]

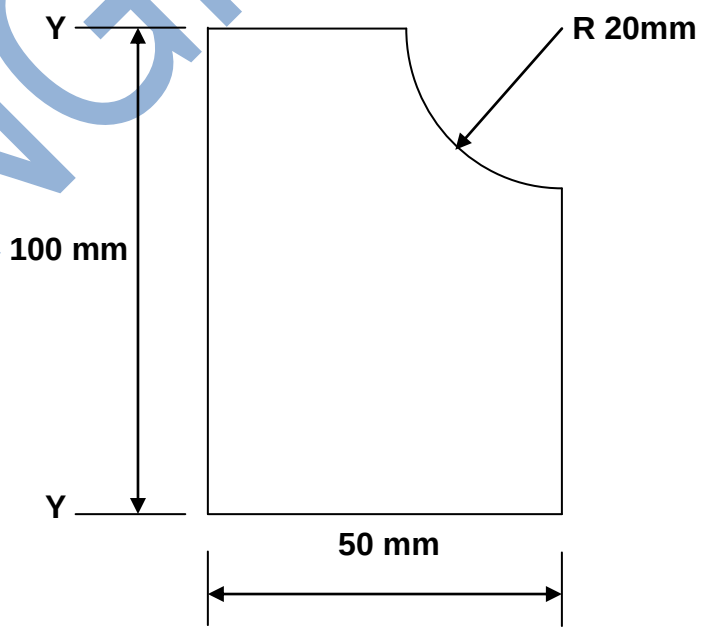

FIGURE 2

QUESTION 5

5.1 Name THREE types of stresses. (3)

5.2 A square aluminium bar is placed in tension by a force of 500 kN.

Calculate the dimensions of the bar if the stress is not to exceed 20 mPa. (3)

5.3 The following readings were obtained in a tensile test on a mild steel bar:

Load in kN	2,5	9,87	17,27	24,7	32,1	33,4	31,3
Extension in mm	0,0056	0,0246	0,0456	0,066	0,0896	0,113	0,225

Gauge length = 56 mm
Original diameter of bar = 11,27 mm

5.3.1 Draw the stress-strain graph for the given values. (5)

5.3.2 Determine Young's modulus from the graph. (1)

5.3.3 Calculate the percentage reduction in cross-sectional area if the diameter of the rod was 6,51 mm at fracture. (2)

[14]

QUESTION 6

6.1 State *Boyle's law.* (2)

6.2 What is the difference between the *Kelvin scale* and the *Celsius scale*? (2)

6.3 A steel plate with dimensions 800 mm × 400 mm × 200 mm lies in an electric furnace. The steel plate is heated from 20 °C to 350°C. The coefficient of the linear expansion of steel is 17×10^{-6}/°C.

Calculate:

6.3.1 The expansion in the length of the plate (2)

6.3.2 The area in mm^2 of the 800 mm x 400 mm side at the temperature of 350 °C (3)

6.3.3 The increase in volume in m^3 (3)

6.4 The volume of a gas is 1,2 m^3 at 30 °C and at a pressure of 600 kPa.

Calculate the thermodynamic temperature of the gas if the volume is 0,85 m^3 at a pressure of 900 kPa. (3)

[15]

QUESTION 7

7.1 Define a *Pascal*. (2)

7.2 Define *Pascal's law*. (3)

7.3 The piston of a single-acting water pump has a diameter of 100 mm and a delivery stroke of 80 mm. The water must be pumped to a vertical height of 20 m.

Calculate:

7.3.1 The volume of water which is being pumped per delivery stroke (3)

7.3.2 The mass of water pumped per delivery stroke (2)

7.3.3 The work done per stroke (3)

7.4 The following data refer to a single-acting hydraulic press:

Plunger diameter = 80 mm
Plunger stroke = 120 mm
Ram diameter = 300 mm
Slip = 5%

Calculate:

7.4.1 The actual volume of liquid delivered to the ram per stroke (3)

7.4.2 The distance moved by the ram after FIVE pumping strokes of the plunger (4)

[20]

TOTAL: 100

ENGINEERING SCIENCE N4

FORMULA SHEET

Any applicable formula may also be used.

$S = \frac{u + v}{2} \times t$

$\overline{V} = \frac{s}{t}$

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

$v_g = \frac{u + v}{2}$

$\omega = 2\pi N$

$\omega = \frac{\theta}{t}$

$\theta = \frac{\omega_2 + \omega_1}{2} \times t$

$\omega_2 = \omega_1 + \alpha t$

$\theta = \omega_1 t + \frac{1}{2}\alpha t^2$

$v = \omega R$

$\theta = 2\pi n$

$S = R\theta$

$\alpha = \frac{\omega_2^2 - \omega_1^2}{2\theta}$

$a = \alpha R$

$v = \pi DN$

$T = FR$

$AV = T\theta = WD$

$P = 2\pi NT$

$P = Fv$

$P = T\omega$

$F_a = ma$

$E_p = mgh$

$E_k = \frac{1}{2}mv^2$

$P = \frac{F}{A}$

$m = \rho \times vol$

$P = \rho gh$

$\frac{W_r}{F_p} = \frac{D^2}{d^2}$

$W.D. = P \times V = A.V.$

$H.V. = \frac{F_p}{F_h} = M.$

$AV = mgh = WD$

$Q = mc\Delta t$

$\Delta l = l_o \alpha \Delta t$

$\beta = 2\alpha$

$\gamma = 3\alpha$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$PV = mRT$

$\in = \frac{x}{l}$

$E = \frac{\sigma}{\in}$

$\sigma = \frac{F}{A}$

$E = \frac{Fl}{Ax}$

$\bar{y} = \frac{A_1y_1 \pm A_2y_2 \ldots}{A_1 \pm A_2 \ldots}$

$\bar{y} = \frac{v_1y_1 \pm v_2y_2 \ldots}{v_1 \pm v_2 \ldots}$